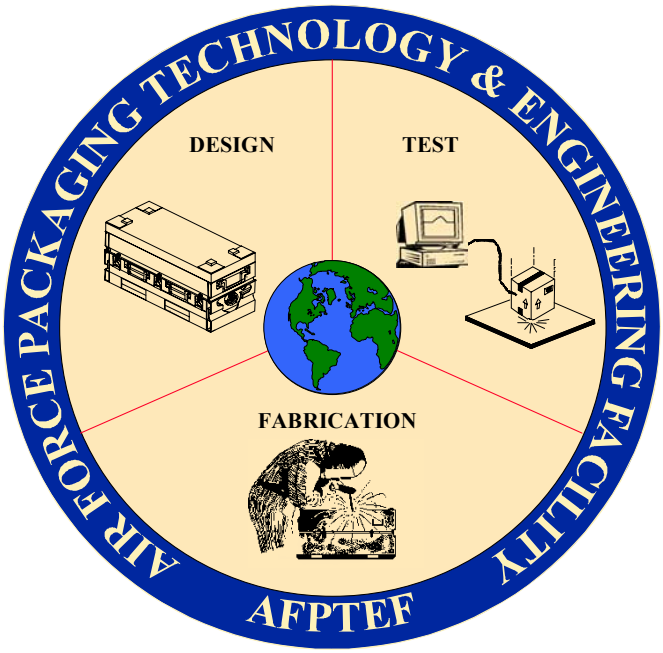


AFMC LSO/LOP
5215 THURLOW ST
WRIGHT-PATTERSON AFB OH
45433-5540
FAX: 937-656-1350
PHONE: 937-257-3362

PACKAGING PERFORMANCE TESTING OF A 30-GALLON STEEL DRUM CONTAINING ONE 2.5 GALLON PLASTIC JUG – PACKING GROUP II

Date: September 24, 2002

AFPTEF PROJECT NUMBER: 02-P-105
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-D030

Part 1.

A. Title: PACKAGING PERFORMANCE TESTING OF A 30-GALLON STEEL DRUM CONTAINING ONE 2.5 GALLON PLASTIC JUG –PACKING GROUP II

Report Number: DLA-D030
AFPTEF Project Number: 02-P-105
Manhours: 40

Report Type: **FINAL**

B.
TEST REPORT APPLICABILITY STATEMENTS see section 2E.

Report Prepared by:

SUSAN J. EVANS
Mechanical Engineer

Approved by:

MICHAEL WERNEKE
Reviewer

ROBBIN L. MILLER
Chief, AF Packaging Technology and Engineering

Testing Completion Date: 18 Sep 02

Approved for Publication and Dated: 23 Sep 02

Responsible Individual: Robbin L. Miller

Performing Activity: AF Packaging Technology and Engineering Facility
AFMC LSO/LOP
5215 Thurlow St
WPAFB OH 45433-5540

Specific Authority: Distribution Statement F. Further dissemination only as directed by AFMC LSO/LOP or higher DoD authority.

Requesting Organization: Defense Distribution Center
DDC-J-3/J-4-0
ATTN: POP Team
2001 Mission Drive
New Cumberland PA 17070

Requesting Organization's Reference(s):
(1) Letter 01 May 2002

Part 2. Data Sheet

A. Exterior Shipping Container

UN Type: Steel Drum, Open Head
UN Code: 1A2
NSN: 8110-00-366-6809
Container Manufacturer: Myers Container Corporation, Emeryville CA 94662
Date of Manufacture: 1999 (see Part 3.)
Material: Steel
Container Dimensions: 18.25 in. diameter x 29.0 in. high
Closure (Type/Method): Locking ring, nut, bolt, with EPDM gasket; 7/16 in. diameter.
Absorbent Material Description: Vermiculite, Fine Grain, Palmetto Vermiculite Company, Incorporated, Grade C-3; Hazmatpac A-900, HAZMATPAC Inc.; and Absorbent GP, Absorption Corporation.
Additional Description: N/R

B. Inner Packaging of Combination Packaging

Type: Oblong , fluorinated, white, HDPE, plastic container (jug).
NSN: N/A
Manufacturer/Distributor: Freund Container, Inc., Chicago IL
Date of Manufacture: 2002
Manufacturer's Number(s): 31325F
Capacity: 2.5 gallon
Dimensions: 9 in. x 6.25 in x 14.50 in tall (to handle/opening), 12 in. tall (body of bottle); mouth diameter: 2.48 inches.
Closure (Method/Type): Screw cap (plastic).
Secondary Closure (Method/Type): One strip of reinforced tape (A-A-1687 Fiber Reinforced Tape, 1-inch; NSN 7510-00-582-4772) wrapped a minimum of 1 ½ times around and overlapping the cap(s) base and the bottle neck(s).
Additional Description: Inner packaging of tested item (see photos, Figures 1 – 3, and drawing).
1. Line the drum with a 4-mil gussetted polyethylene bag, with minimum dimensions of 22 in. x 16 in. x 59 in.
2. Place absorbent in bottom of drum and shake down, adding more absorbent as needed, to a depth of approximately 7 inches. [If using HAZMATPAC A-900 or Absorbent GP, firmly compress the bottom layer and add/compress absorbent to a depth of 7 inches.] Place 1 jug on absorbent layer, centered horizontally in the drum. Fill open space surrounding the jug with absorbent until jug top is reached (if using Absorbent GP or A-900, firmly compress approximately every 2 inches and add material until jug top is reached). Cover with a minimum of 7 in. of firmly packed absorbent. **NOTE: The quantity of absorbent used DOES meet the requirements of AFJMAN 24-204(I), Atch 20, and this packaging is intended for transportation by Military Aircraft.**
3. Shake down and firmly compress, and add absorbent if necessary to make a tight pack within the outer container.
4. Twist bag and tape closed with fiber reinforced tape.
5. Closure IAW 2A.

C. Actual Product: Not Used

NSN: 6850-01-383-0366, Inhibitor, corrosion, water-soluble
Specification: Unknown
UN/DOT/IMO/IATA Proper Shipping Name: Unknown
United Nations Code Number: Unknown
United Nations Packing Group: I
UN Hazard Class: Unknown **DOT Hazard Class:** Unknown
IMO Hazard Class: Unknown **IATA Hazard Class:** Unknown
Physical State: LIQUID
Amount per container: One 2.5 gallons {maximum of 10.9 kg (24 lb)}
Gross Weight (packaged with vermiculite): maximum of 46.27 kg (102 lb)
Gross Weight (packaged with HAZMATPAC A900): maximum of 54.43 kg (120 lb)

Density/Specific Gravity: Unknown
Drop Height: 1.8 meters (71 in.)
Minimum Stacking Weight/Force Required: 167.05 kg (368.28 lb) [based on test product]
Additional Description: N/A
Vapor Pressure (liquids only) at 50ºC: Unknown

D. Test Product: Used
Name: Propylene glycol/water mix.
Physical State: LIQUID
Amount per container: One 2.5 gallon {10.9 kg (24 lb)}
Gross Weight (packaged with vermiculite): 46.27 kg (102 lb)
Gross Weight (packaged with HAZMATPAC A900): 54.43 kg (120 lb)
Density/Specific Gravity: 1.0
Drop Height: 1.2 m (47.24 in.)
Minimum Stacking Weight/Force Required: 167.05 kg (368.28 lb)

E. Test Applicability- See test results in Part 6.

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier’s operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT’s or international’s regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run’s individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3. Introduction.

Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

Packing Group II testing was requested on the above stated configuration. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g). This packaging is intended for transportation by Military Aircraft.

Each packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking test was performed on an empty outer container.

The outer container design used in this configuration has been tested by the manufacturer as a single packaging for PG II liquids with a specific gravity up to 1.5, at a pressure of 150 kPa. Although the drum used in this testing was manufactured in 1999, DLA warehouses and GSA may stock drums manufactured in later years also; therefore, UN test reports for 1999, 2000, 2001 and 2002 are supplied in Appendix A in lieu of repeating the leakproofness and hydrostatic pressure tests. **Because the outer container's performance as a container for PG I, II and III solids has been proven for these four years, this packaging configuration is approved for use in drums manufactured in years 1999 through 2002.**

This configuration was tested using only vermiculite and Hazmatpac A900 as the cushioning absorbent. However, Absorbent GP has consistently provided superior cushioning and protection for inner packagings. **Therefore, by analogy, and through previous test experience with other, more fragile packaging configurations, Absorbent GP is also approved for use in this configuration.**

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 6.

Part 4. Tests Required/Performed (as applicable).

A. Leakproofness test. 3 outer containers each individually tested for 5 minutes (30 minutes for plastic containers).

B. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 15 psig.

C. Stacking Test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours. **NOTE:** If only one configuration sample is tested, test duration shall be 72 hours.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m\,(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = **54.43 kg**
h = container's height in millimeters = **736.6 mm** (effective height for container in stack)
M = constant load mass in kilograms = **167.05 kg**

or:
$$W = \frac{w\,(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = **120 lb**
h = container's height in inches = **29.0 in.** (effective height for container in stack)

W = constant load weight in pounds = **368.28 lb**

Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

D. Drop Test. 6 drops in order. First drop, using 3 samples: Package must strike the target diagonally on the chime, or if no chime, on a circumferential seam or an edge. Second drop, using 3 samples: Package must strike the target on the weakest part not tested by the first drop, for example a closure or a welded longitudinal seam of the drum body. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact. **NOTE:** All drops may be made on only one sample. If the sample fails after drops 2 through 6, it may be replaced by another sample identically loaded. This option was used as noted in Part 3.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm^3 (specific gravity less than 1.2) the drop height shall be:

Packing Group	Drop Height
I	**1.8m** (70.9 in.)
II	**1.2m** (47.2 in.)
III	**0.8m** (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

Packing Group	Drop Height
I	**(d) x 1.5m** ((d) x 59.1 in.)
II	**(d) x 1.0m** ((d) x 39.4 in.)
III	**(d) x 0.67m** ((d) x 26.4 in.)

Round the drop height up to the first decimal.

E. Vibration Test (domestic requirement). One test per container, total of three test specimens.
The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE:** If only one configuration sample is tested, test duration shall be 3 hours.

Part 5. Criteria for Passing Tests.

A. Leakproofness Test. There must be no leakage of air from the packaging.

B. Hydrostatic Pressure Test. Any leakage is cause for rejection.

C. Stacking Test. No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

D. Drop Test. Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

E. Vibration Test. No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

Part 6. Discussion and Test results.
Narrative description of test results, including any rationale for variations. For each packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Leakproofness Test. Pass (Manufacturer test results provided in Appendix A.)

B. Hydrostatic Pressure Test. Pass (Manufacturer test results provided in Appendix A.)

C. Drop Test. Pass (See also manufacturer test results provided in Appendix A.)
Tested at standard conditions: 23º C., 50% RH. Each packaging was dropped 1.2 meters to strike the chime diagonally 3 times; it was then dropped diagonally onto the closing ring three times with each impact a different point near the closing bolt. The plastic jug cushioned by vermiculite shifted position within the drum, migrating closer to the top. There was no damage after any one drop to the inner or outer packagings that would be likely to cause leakage from, or weakening of, the packagings during transportation. See Figure 5.

D. Stacking Test. Pass (See also manufacturer test results provided in Appendix A.)
Tested at ambient conditions. One empty closed outer container was stacked with 600 lb for 72 hours. There was no damage to the drum which could result in damage to the inner item, no crushing, nor stack instability. No other adverse results were noted. See Figure 4.

E. Vibration Test. Pass (See also manufacturer test results provided in Appendix A.)
Tested at ambient conditions. The same packagings used in the drop tests were also used for the vibration test. Each packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At approximately 4.19 Hz the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the outer container caused by the vibration and no leakage from the battery. This test procedure duration of 3 hours with one container exceeds the 49 CFR requirements. See Figure 6.

Part 7. Performance Marking on Container:
The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

un **1A2/Y54.4/S/02/USA/DOD**

Part 8. References
- **A.** 49CFR 170-180
- **B.** DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- **C.** ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)

D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

Commander
Defense Logistics Agency
DDC-J-3/J-4-0
ATTN: Linda McCarthy
2001 Mission Drive
New Cumberland PA 17070

AFMC LSO/LOP
Project Folder

Figure 1. Placement of one 2.5-gallon plastic jug in outer container.

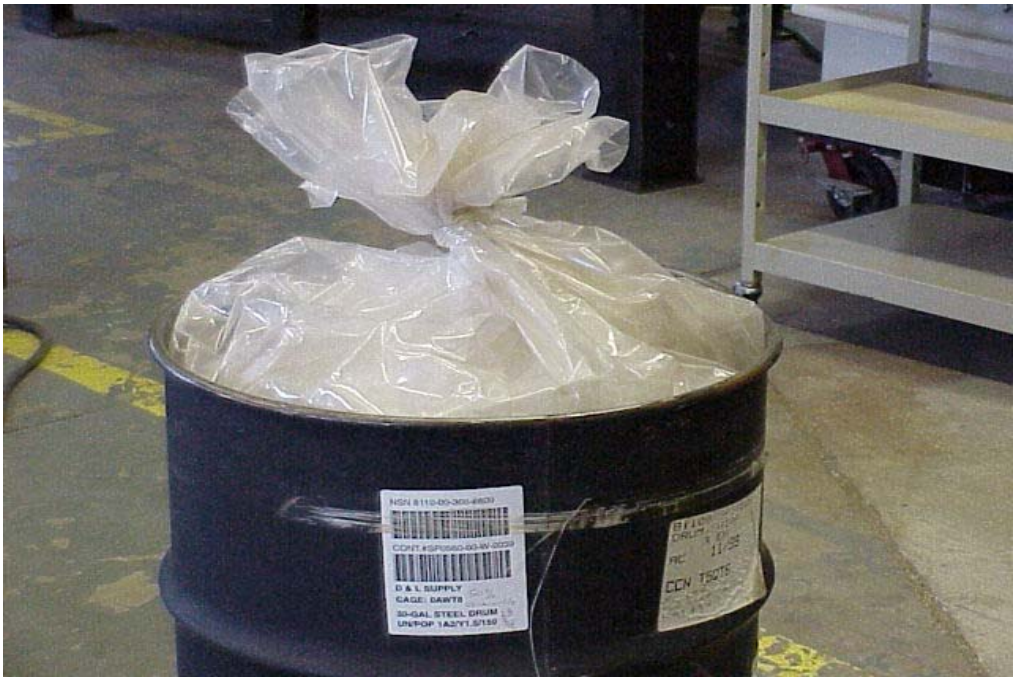


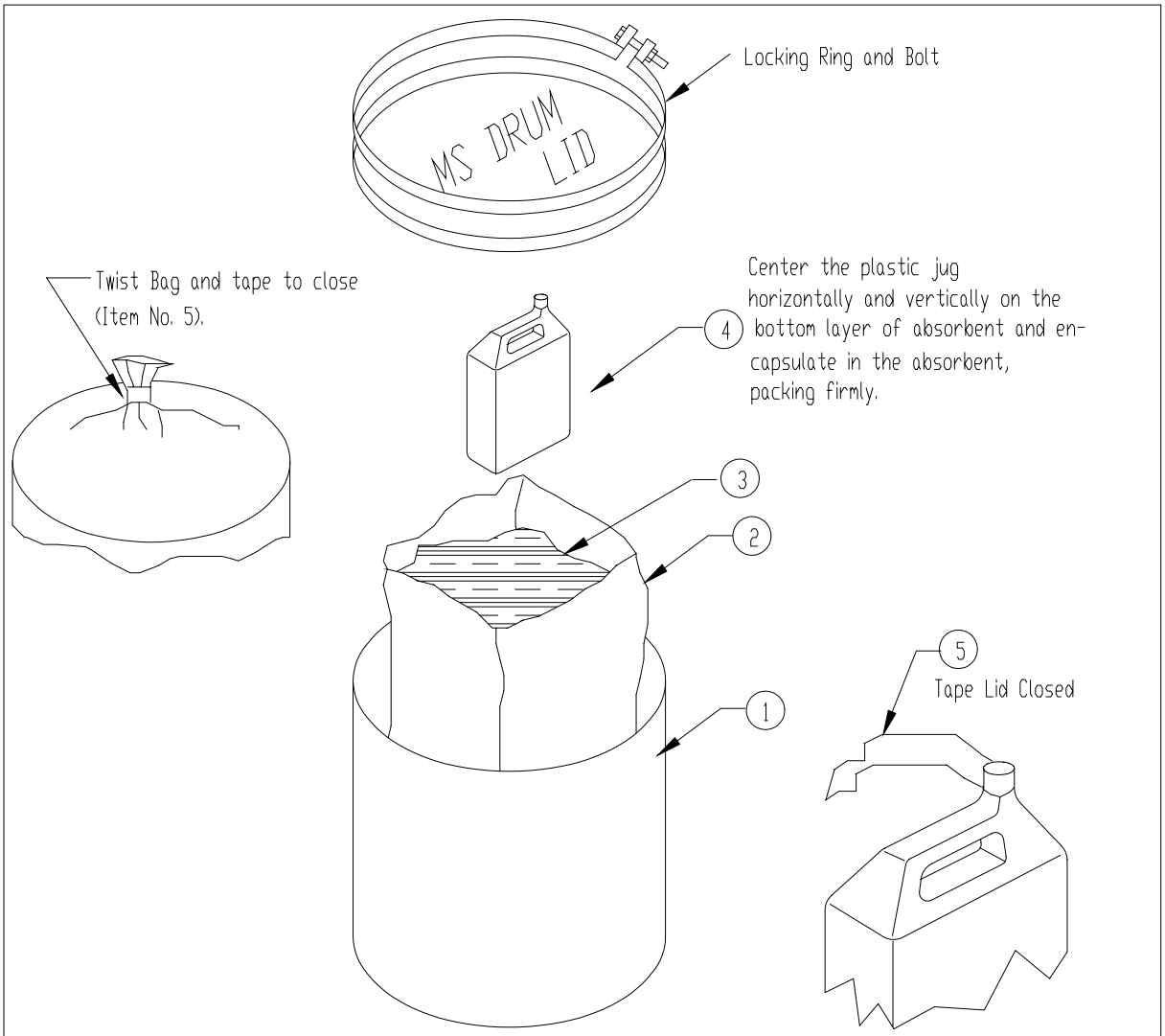
Figure 2. Closure of inner liner enclosing 2.5-gallon jug and cushioning absorbent.

Figure 3. Closure of outer container.

Figure 4. Stack test.

Figure 5. Drop test.

Figure 6. Vibration test.



Item	Qty	Description	Notes
5	A/R	Fiber Reinforced Tape	7510-00-582-4772
4	1	Inner Container, 2.5-Gal Rect. Plastic w/ Handle	Freund stock number 31325F, fluorinated, white, HDPE.
3	A/R	Absorbent Fill	Vermiculite or Absorbent A900 or Absorbent GP
2	1	4-mil LDPE Bag	Min. Dim. 22 in. x 16 in. x 59 in., gussetted.
1	1	Steel Open Head Drum	8110-00-366-6809

File: DLAD030-02.DWG	AFPTEF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
Dwg No: DLAD03002D		Dimensions in Inches
Engineer: SJ Evans	DATE: 23 September 02	Scale: NONE
		PAGE 1 OF 1

APPENDIX A

Manufacturer UN Test Summary